CHEM 1006/1015 Inorganic in-class test (Reid and Hector)

Feedback sheet for: Joe Bloggs – your provisional mark is 8 out of 15

You've passed, so well done, but make sure you think carefully about what you can do to improve.

For each question, you can see the responses of the whole class and your own personal feedback for the question is given below.

Gill Reid, Andrew Hector and David Read

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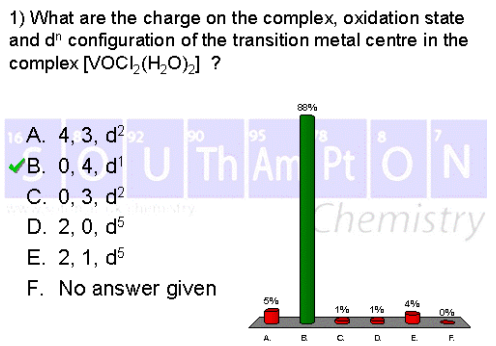
1) What are the charge on the complex, oxidation state and d^n configuration of the transition metal centre in the complex $[VOCl_2(H_2O)_2]$?

a. 4, 3, d^2
b. 0, 4, d^1
c. 0, 3, d^2
d. 2, 0, d^5
e. 2, 1, d^5



Feedback:

Your response:

B - correct, well done!

Reading:

Shriver and Atkins p. 39 - Ox states & determination; p. 438-439 - Trends.

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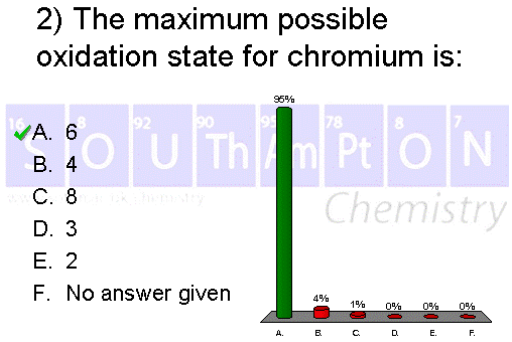
2) The maximum possible oxidation state for chromium is:

a. six
b. four
c. eight
d. three
e. two



Feedback:

Your response:

A - this is correct since Cr is in Group 6 - well done.

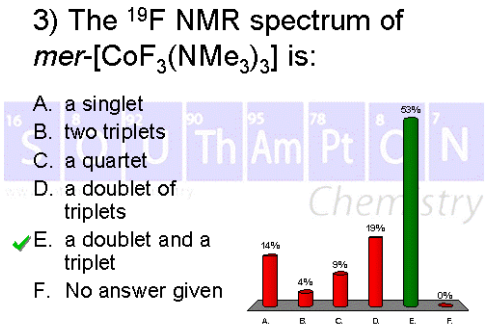
Reading:

As above: Shriver and Atkins p. 39 - Ox states & determination; p. 438-439 - Trends.

3) The ^{19}F NMR spectrum of *mer*-$[CoF_3(NMe_3)_3]$ is:

a. a singlet
b. two triplets
c. a quartet
d. a doublet of triplets
e. a doublet and a triplet

[^{19}F: I = ½ 100%; ignore coupling to other nuclei]



Feedback:

Your response:

A - incorrect as there are 2 F environments, hence must be 2 resonances.

Reading:

For some background info on how NMR works - see p. 177-181 in Shriver & Atkins.

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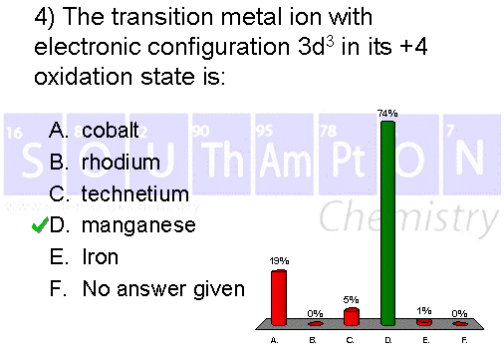
4) The transition metal ion with electronic configuration $3d^3$ in its +4 oxidation state is:

a. cobalt
b. rhodium
c. technetium
d. mangnese
e. iron



Feedback:

Your response:

D - correct as Mn is a 3d element and Mn is in Gp 7, so Mn(IV) is d3.

Reading:

As Q1 & 2: Shriver and Atkins p. 39 - Ox states & determination; p. 438-439 – Trends.

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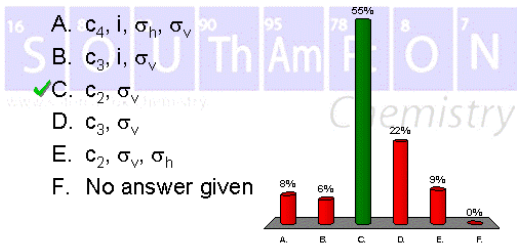
5) Which of the following sets of symmetry elements best describes the structure of tetrahedral $[NiCl_2(PPh_3)_2]$?

a. C_4, i, σ_h, σ_v
b. C_3, i, σ_v
c. C_2, σ_v
d. C_3, σ_v
e. C_2, σ_v, σ_h

5) Which of the following sets of symmetry elements best describes the structure of tetrahedral $[NiCl_2(PPh_3)_2]$?



Feedback:
Your response:
D - incorrect as there is no c3 rotation axis.

Reading:
For symmetry elements and operations, see p. 196-198 in Shriver and Atkins (you don't need to tackle point groups yet – this comes up in Year 2).

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6) How many different isomers are possible for $[Re(CO)_2(Me_2NCH_2CH_2NMe_2)_2]^+$?:

a. 2
b. 3
c. 4
d. 5
e. 6

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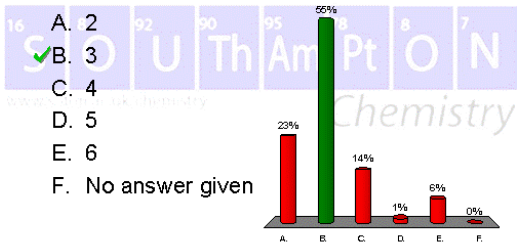

Feedback:
Your response:
C - incorrect as trans isomer does not have optical isomers

Reading:
For isomerism, see p. 229-235 in Shriver and Atkins.

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7) Which of the following ligands would be best suited to stabilising Mn(0)?

a. O^{2-}
b. Cl^-
c. H_2O
d. NEt_3
e. CO

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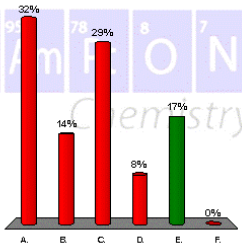
C. H_2O
D. NEt_3
✔E. CO
F. No answer given



Feedback:

Your response:

C - incorrect as H2O is a sigma donor ligand which stabilises medium (usually +2, +3) oxidation states.

Reading:

For the molecular orbital bonding scheme for CO, see p. 59 in Shriver and Atkins - this shows that the LUMO is pi* in nature and should support the material covered in GRs 3rd lecture. For a discussion of sigma and pi bonding see p. 469-472 (don't worry about the labels yet - we will deal with these later - just focus on the types of ligands in each category and the orbital interactions).

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8) Which of the following is an accurate description of a unit cell?

a. The smallest repeating cell that describes the full structure of the lattice
b. The highest symmetry cell available
c. The smallest repeating cell that shows the full symmetry of the lattice
d. The lowest symmetry cell available
e. The highest symmetry small cell

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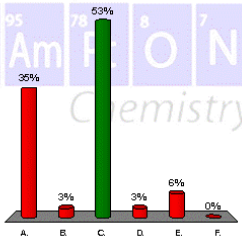
B. The highest symmetry cell available
✔C. The smallest repeating cell that shows the full symmetry of the lattice
D. The lowest symmetry cell available
E. The highest symmetry small cell
F. No answer given



Feedback:

Your response:

C - correct. First choose the highest symmetry then the smallest cell within it.

Reading:

Shriver and Atkins p. 72-73 explains unit cells, definition given in lecture 1 handout.

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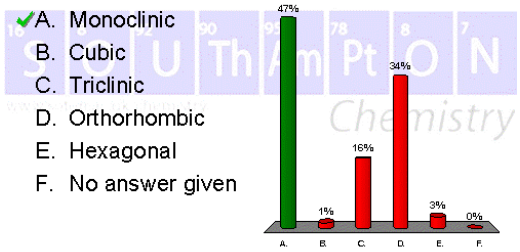
9) In which crystal system could a unit cell have dimensions a = 3.42 Å, b = 7.21 Å, c = 3.47 Å, α = 90°, β = 92.1° and γ = 90°.

a. Monoclinic
b. Cubic
c. Triclinic
d. Orthorhombic
e. Hexagonal

9) In which crystal system could a unit cell have dimensions *a* = 3.42 Å, *b* = 7.21 Å, *c* = 3.47 Å, α = 90°, β = 92.1° and γ = 90°.



Feedback:

Your response:

D - incorrect as orthorhombic cells have a ≠ b ≠ c and α = β = γ = 90°.

Reading:

Shriver and Atkins p. 72-73 defines crystal systems.

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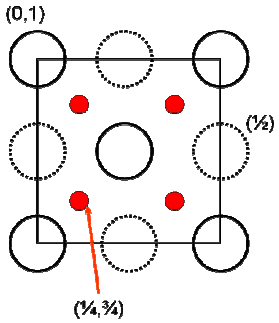
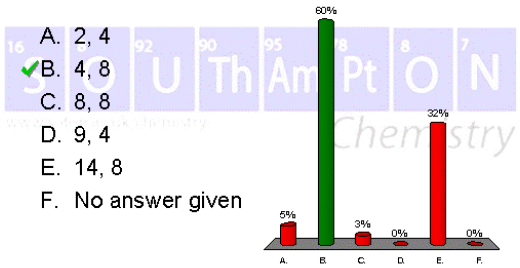
10) How many O and Li ions are in the following unit cell?

a. 2, 4
b. 4, 8
c. 8, 8
d. 9, 4
e. 14, 8



(large circles O, small circles Li)

10) How many O and Li ions are in the following unit cell?



Feedback:

Your response:

B - correct as there are 4 large spheres (8×1/8 + 6×½) and 8 small spheres (all inside the cell).

Reading:

Shriver and Atkins p. 73-74 discusses projection drawing of unit cells and p. 86 covers atom counting in unit cells. Fluorite/antifluorite structures also discussed on p. 86.

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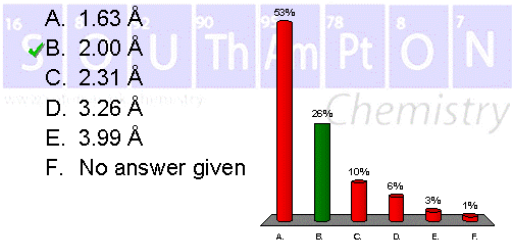
11) The unit cell shown in the previous question has a lattice parameter of 4.61 Å. What is the Li-O bond distance?

a. 1.63 Å
b. 2.00 Å
c. 2.31 Å
d. 3.26 Å
e. 3.99 Å

11) The unit cell shown in the previous question has a lattice parameter of 4.61 Å. What is the Li-O bond distance?



Feedback:

Your response:

A - incorrect. The answer is a quarter of the way from one corner to the opposite corner across the cube, this is a quarter of the diagonal across one face.

Reading:

Similar examples have been covered both in workshops and in the lectures.

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12) In the structure of ZrP, Zr atoms occupy octahedral holes in a close packed lattice of P atoms. What fraction of octahedral holes is filled?

a. All of them
b. ¾
c. $^{2}/_{3}$
d. ½
e. ¼

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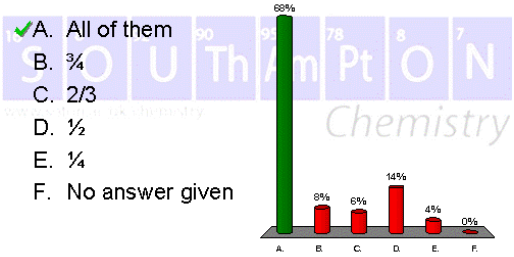

Feedback:

Your response:

A - correct as the ratio of spheres in the close packed array to octahedral holes is 1:1.

Reading:

Holes in close packed structures are discussed on p. 76-77 of Shriver and Atkins.

13) What is the packing density of a body centred cubic lattice?

a. 48%
b. 54%
c. 60%
d. 68%
e. 74%

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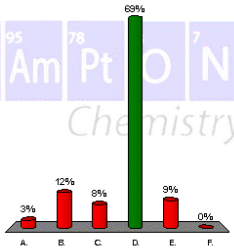
A. 48%
B. 54%
C. 60%
✔D. 68%
E. 74%
F. No answer given



Feedback:

Your response:

D - correct, as shown at the end of lecture 2.

Reading:

This calculation is from lecture 2. Packing densities are discussed on Shriver and Atkins p. 74-76 and for bcc on p. 79.

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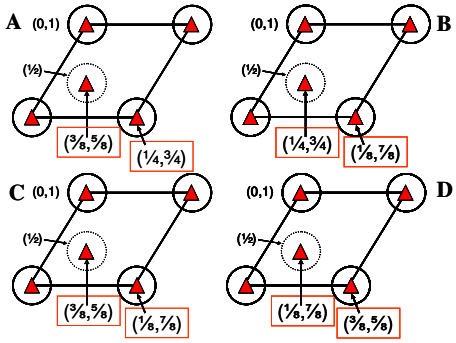
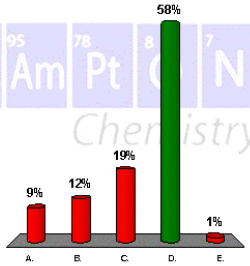
14) Which projection drawing correctly gives the positions of the tetrahedral holes in hexagonal close packing?



14) Which projection drawing correctly gives the positions of the tetrahedral holes in hexagonal close packing?

A.
B.
C.
✔D.
E. No answer given



Feedback:

Your response:

D - correct as the tetrahedral holes are always 3/8 of a unit cell above and below every atom.

Reading:

For more information, see Shriver and Atkins p. 76-78.

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15) What is the coordination number of Cs in CsCl?

a. 2
b. 3
c. 4
d. 6
e. 8

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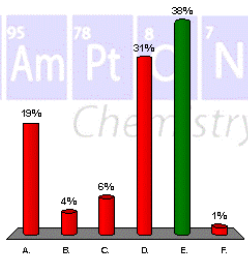

Feedback:

Your response:

A - incorrect as CsCl is formed from Cs occupying cubic holes in a primitive cubic lattice.

Reading:

The CsCl structure is discussed on Shriver and Atkins p. 86.